ECONOMICS OF CONVERTING FROM FLOOD IRRIGATION TO CENTER PIVOT SPRINKLER IRRIGATION

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SUMMARY

An economic analysis was conducted to analyze the feasibility of converting from flood to center pivot sprinkler irrigation for corn production in western Kansas. The analysis revealed that investing in a center pivot sprinkler system would increase returns compared to flood irrigation. The relative profitability of the two systems were insensitive to typical pumping costs, but were very sensitive to initial investment, payback period, corn yield potential, and acres irrigated. Factors affecting the economic feasibility of converting from flood to center pivot vary considerably between producers; therefore, it is important for each producer to analyze the profitability of conversion for their operation.

INTRODUCTION

Crop production from irrigated land in western Kansas provides an important contribution to the economy of the state. Irrigated crop production is the largest permitted water use in the state of Kansas. However, declines in groundwater resources have emphasized the need to use this limited resource in an efficient manner while still considering the economic impact on individual producers. In addition to decreasing water supplies, increasing energy costs are encouraging producers to look at methods of improving irrigation efficiency. Improvement in irrigation water use efficiency, whether through better management techniques or system efficiency improvement, may be able to accomplish partial conservation of water resources and preservation of returns to irrigation farmers.

One of the biggest improvements that can be made regarding irrigation water application efficiency is the conversion of flood or furrow irrigation to center pivot sprinkler irrigation. Irrigation water use reports from the Kansas Division of Water Resources (DWR) indicate there were more acres irrigated with center pivot sprinkler than surface irrigation in 1992. However, in western Kansas where irrigation water use is higher than other areas of the state, there were more acres irrigated with surface systems than with center pivot sprinkler systems. The three Groundwater Management Districts in western Kansas accounted for 73.2% of the state's irrigated acres in 1992. This indicates that the western region of the state offers the greatest potential for water savings through improved application and water use efficiency.

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When managed properly, the application efficiency of a center pivot system can be significantly higher than flood irrigation. However, converting to center pivot sprinkler from flood irrigation requires a large capital investment. The production and economic benefits of center pivot systems will vary considerably among producers; thus, it is important for producers to analyze the economic feasibility of conversion before making any investment decisions.

Many producers believe that converting from flood irrigation to a center pivot sprinkler system will decrease energy costs. Irrigation pumping costs per inch of water will not decrease necessarily with center pivot because of increased pumping pressure. The effect on total annual energy costs will depend on total water pumped. If water use per acre remains the same as flood levels or acres irrigated increase, there may not be any total water savings with center pivot compared to flood irrigation. However, irrigation water use efficiency (production per inch of water) should be higher with center pivot because of the improved application efficiency.

ECONOMIC ANALYSIS METHODOLOGY

The economic profitability of converting from flood to center pivot sprinkler irrigation was analyzed using partial budgeting. Partial budgeting analyzes the profitability of an investment, but unlike whole-farm budgeting it does not indicate whether or not the farm as a whole is profitable because only income and costs directly affected by the investment are included in the analysis. This type of analysis allows the producer to see how much a new investment either needs to be subsidized or contributes to the rest of the farm operation.

Because a center pivot sprinkler system is a long-term investment, the net present value of returns from the partial budget was calculated. Net present value (NPV) takes into account the time value of money because it discounts costs and returns that are realized in future years. This method is useful when there is a long payback period and in cases where income and/or costs vary from year-to-year over the investment period considered. Even though returns were considered constant from year-to-year in this analysis, NPV was used because of the long payback period assumed. From an economic standpoint, a positive NPV indicates returns will be increased by converting to center pivot. Producers may want to develop a partial budget that analyzes the cashflow consequences of converting to center pivot because the cashflow implications can be different than the long run economic potential.

Investment analyses will often calculate an after-tax return. While the tax implications of converting irrigation systems cannot be ignored, they will vary considerably among producers so they were not included in this analysis. Therefore, all reported returns are on a before-tax basis.

The first step in the economic analysis was to determine the investment requirement of the center pivot sprinkler system (Table 1). The system investment was based on a low pressure system with drops on 5.0 foot spacings irrigating 126 acres. The investment also included 1,320 feet of underground pipe and electrical wiring. It was also assumed that there would be a cost of modifying the pump. If there is flood irrigation equipment (gated pipe, surge valves, etc.) that could be sold, the initial investment of the center pivot system could be decreased by that amount. For this analysis it was assumed the flood irrigation equipment had minimal salvage value so it was not factored in.

Annual ownership costs of the center pivot system was calculated by amortizing the system cost over its estimated useful life of 15 years at 9 percent interest. It is very possible that a sprinkler system could have a positive salvage value at the end of 15. However, due to the uncertainties associated with depth to water, energy costs, and potential obsolescence at the end of the payback period, a zero salvage value was assumed for the analysis.

The second step in the economic analysis was to determine the level of three key production parameters; acres irrigated, crop yield potential, and the amount of irrigation water applied (Table 3). These figures are correlated and vary with well capacity, irrigation system, field size, soil type and location. The center pivot sprinkler system was assumed to irrigate 126 acres of corn versus 80 acres with flood irrigation. Acres not in irrigated corn production were assumed to be in a wheat-fallow rotation. Irrigated corn yields were initially assumed to be equal for both systems at 175 bu/ac. The amount of irrigation necessary for optimal yields will vary by year, location, management, and system. For the analysis, approximately 20 acre inches of irrigation water was used with the center pivot sprinkler system and 32 acres inches with the flood system. These values are based on water use requirement studies conducted in Kansas and an application efficiency of 90% for center pivot and 55-60% for flood.

Based on the production assumptions used, production expenses were $30/acre higher for flood than center pivot irrigated corn (Table 4). This was due to higher labor requirements and increased pumping costs. Income per irrigated acre was constant because assumed yields were equal for both systems. Government program payments were assumed to be equal for both systems so they were not included in the analysis. Machinery ownership costs (depreciation, interest, and insurance) were not included in the analysis. It was assumed there would be no difference in machinery requirements between the two systems.

RESULTS AND DISCUSSION

The center pivot sprinkler system had an annual economic advantage of $1,276 ($7.97/acre) over the flood system (Table 5). The total economic advantage over the life of system was $19,134 with a NPV of $10,282. In other words, the net returns of the center pivot sprinkler over the life of the system are equivalent to $10,282 today. The center pivot system irrigated more acres thereby generating significantly more gross income. However, increased total production expenses and annual ownership costs of the center pivot system offset much of this increased income.

Annual ownership costs were calculated as the initial investment cost of the system ($53,490) amortized over the expected life of the system (15 years) at 9% interest.

The relative returns of both the center pivot sprinkler and flood irrigation systems were very sensitive to changes in certain variables. A sensitivity analysis was done to determine how changes in major variables affected the relative returns of the two systems. Variation in the initial investment and amortization period for the center pivot sprinkler system was evaluated to determine its impact on NPV. At the base investment ($53,490), NPV was positive with a payback period greater than 11 years (Figure 1). Reducing the initial investment by 20% to $42,792, resulted in a positive NPV with a payback period of eight years or more. Even with a 10% increase in initial investment, NPV was positive over the useful life of 15 years.

Because center pivot sprinklers are more efficient than flood irrigation the benefit of converting increases as irrigation pumping cost increases (Figure 2). Even if there was no charge on pumping costs, converting to center pivot was profitable. This indicates that irrigation pumping costs and the cost savings associated with center pivot are not a major determinant of relative profitability of the two systems in western Kansas.

The sensitivity of NPV to corn yield potential was also analyzed to determine the potential income advantage the center pivot sprinkler system had over the flood system due to more irrigated acres (126 vs. 80). The NPV of converting from flood to center pivot irrigation was zero, indicating a breakeven proposition, if corn yields under center pivot decreased approximately five bu/ac (Figure 3). Yield/acre might decrease as a fixed amount of irrigation water is spread over additional acres. If the initial yield under flood irrigation was 150 bu/ac, the breakeven yield for the center pivot system would be approximately 155 bu/ac. It can be seen in figure 3 that the relative returns of the two systems (NPV) were extremely sensitive to changes in yields.

Initially it was assumed that there were 126 irrigated corn acres with center pivot compared to 80 under flood irrigation. The sensitivity of NPV to varying irrigated acres under flood was analyzed holding acres for center pivot constant at 126. If the flood system could maintain the 175 bu/ac yield on approximately 90 acres or more, NPV was negative indicating it would not be profitable to convert to center pivot.

This analysis indicates that converting from flood to center pivot sprinkler irrigation systems can increase returns for corn in western Kansas. However, the analysis also indicates the relative returns of the two systems as shown by NPV is fairly sensitive to variables such as initial investment and payback period. Returns were extremely sensitive to those variable that directly affect gross income such as yield and acres irrigated. Irrigation pumping costs did not impact the relative profitability of the two systems. This implies that an improvement in income is much more critical than a reduction in costs in order for conversion to be profitable.

Table 1. Investment information for center pivot sprinkler system

Total investment for sprinkler system	$40,000
Pump, gearhead, and motor modification costs	$5,000
Underground pipe and electrical lines, etc.	$8,490
TOTAL INVESTMENT	$53,490
Years for payback	15
Interest rate	9.0%
Annual charge (principal and interest)	$6,636
Salvage value at end of payback period	$0

Table 2. Irrigation pumping and repairs information

PUMPING INFORMATION:	Flood	Pivot
Pumping capacity (gpm)	600	600
Lift (feet)	250	250
Discharge (psi)	10	35
Energy source	Nat. gas	Nat. gas
Energy cost/unit	$2.50	$2.50
NPPPC (%)[1]	75.00	95.00
Total dynamic head (TDH)	273	331
Pumping cost/inch of water	$1.69	$1.61
IRRIGATION REPAIRS & MAINTENANCE	$384	$756

[1] Percent of Nebraska Pumping Plant Performance Criteria

Table 3. Crop acres, yield and water use information

IRRIGATED ACRES	Flood	Pivot
Crop planted	Corn	Corn
Acres planted	80	126
Irrigation days (24 hr/d)	80	80
Total irrigation hours	1,920	1,920
Acre inches applied/acre	32.0	20.3
Yield/acre	175.0	175.0
Value of crop/unit	$2.30	$2.30
Sales income per acre	$402.50	$402.50
DRYLAND ACRES		
Crop planted	Wheat	Wheat
Acres planted	40	17
Yield/acre	35.0	35.0
Value of crop/unit	$2.90	$2.90
Sales income per acre	$101.50	$101.50
Dryland acres fallow	40	17
TOTAL ACRES	160	160

Table 4. Irrigated and dryland crop budgets

IRRIGATED CORN: INPUTS & COSTS/AC	Flood	Pivot
Acres planted	80	126
Inches of water pumped/acre	32.0	20.3
Hours of labor at $8.00 per hour	3.50	2.50
Labor	$28.00	$20.00
Seed	32.00	32.00
Herbicide	26.25	26.25
Insecticide	49.04	49.04
Fertilizer	33.45	33.45
Fuel and oil	8.75	8.05
Machinery repairs	21.50	21.50
Pumping energy	54.01	32.80
Irrigation repairs & maintenance	4.80	6.00
Crop consulting	6.00	6.00
Miscellaneous	7.00	7.00
Operating interest at 9.0%	12.19	10.89
TOTAL OPERATING COST/PLANTED ACRE	$282.99	$252.98

DRYLAND WHEAT: INPUTS & COSTS/AC	Flood	Pivot
Acres planted	40	17
Hours of labor at $8.00 per hour	1.20	1.20
Labor	$9.60	$9.60
Seed	3.12	3.12
Herbicide[1]	9.40	9.40
Insecticide		
Fertilizer	3.60	3.60
Fuel and oil[1]	5.55	5.55
Machinery repairs[1]	11.90	11.90
Crop consulting		
Miscellaneous	5.00	5.00
Operating interest at 9.0%	2.17	2.17
TOTAL OPERATING COST/PLANTED ACRE	$50.34	$50.34

	Flood	Pivot
TOTAL PROPERTY TAXES[2]	$1,086	$1,276

[1] Includes costs associated with fallow acres.
[2] Calculated at 1% of the value of land (irr. = $885/ac and dryland = $472/ac).

Table 5. Returns of center pivot sprinkler vs. flood irrigation

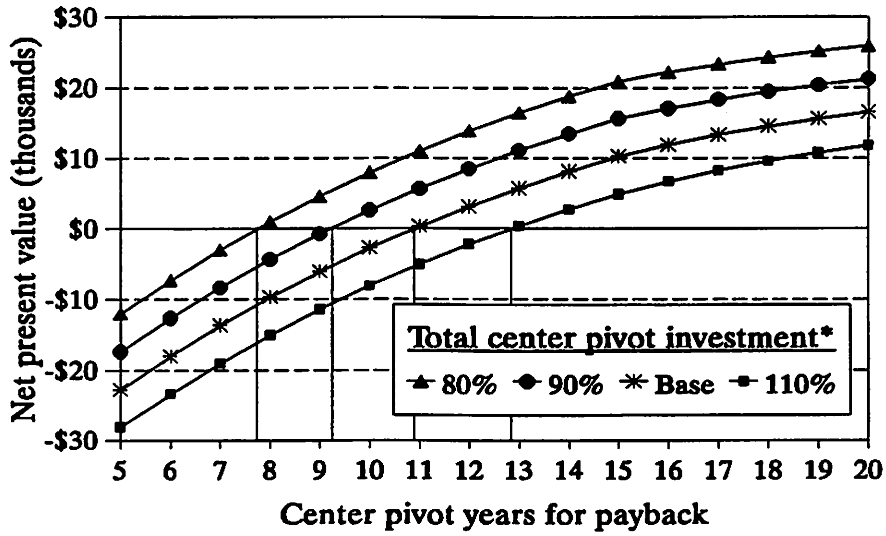
Year	1	2	3	 14	15	Total
CROP INCOME[1]						
Center pivot	52,440	52,440	52,440	52,440	52,440	$786,607
Flood	36,260	36,260	36,260	36,260	36,260	$543,900
Difference	16,181	16,181	16,181	16,181	16,181	$242,708
EXPENSES						
Center pivot	34,007	34,007	34,007	34,007	34,007	$510,107
Flood	25,738	25,738	25,738	25,738	25,738	$386,072
Difference	8,269	8,269	8,269	8,269	8,269	$124,035
EQUIPMENT PAYMENTS						
Principal & interest	6,636	6,636	6,636	6,636	6,636	$99,539
RETURNS TO MGMT, LAND, & MACH.[2]						
Center pivot	11,797	11,797	11,797	11,797	11,797	$176,962
Flood	10,522	10,522	10,522	10,522	10,522	$157,828
Difference	1,276	1,276	1,276	1,276	1,276	$19,134
CUMULATIVE RETURNS						
	1,276	2,551	3,827	17,858	19,134	
RETURNS TO MGMT, LAND, & MACH./ACRE						
Center pivot	$73.73	$73.73	$73.73	$73.73	$73.73	$1,106
Flood	$65.76	$65.76	$65.76	$65.76	$65.76	$986
Difference	$7.97	$7.97	$7.97	$7.97	$7.97	$120
FINANCIAL MEASURES[3]						
Total Net Present Value (NPV)			10,282			
Internal Rate of Return (IRR)			12.1%			

[1] Crop income does not include government payments.

[2] Returns to management, land and machinery represents a return to fixed assets. (the same for center pivot and flood irrigation)

[3] Net present value (NPV) is the returns to fixed assets discounted to current dollars. A positive NPV indicates center pivot is more profitable than flood irrigation. A negative NPV indicates flood irrigation is more profitable.

Internal rate of return (IRR) should be compared with a minimum acceptable rate of return. If the IRR is equal to or greater than the minimum acceptable rate, center pivot would be considered a good investment.



* Total center pivot investment at 100% = $53,490

Figure 1. Net present value of converting from flood to center pivot sprinkler irrigation vs. years for payback and total investment for center pivot sprinkler.

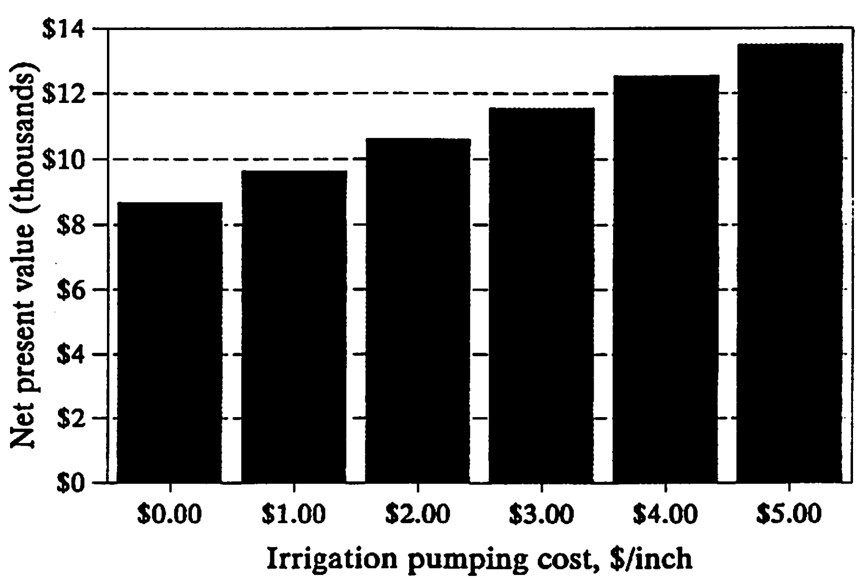
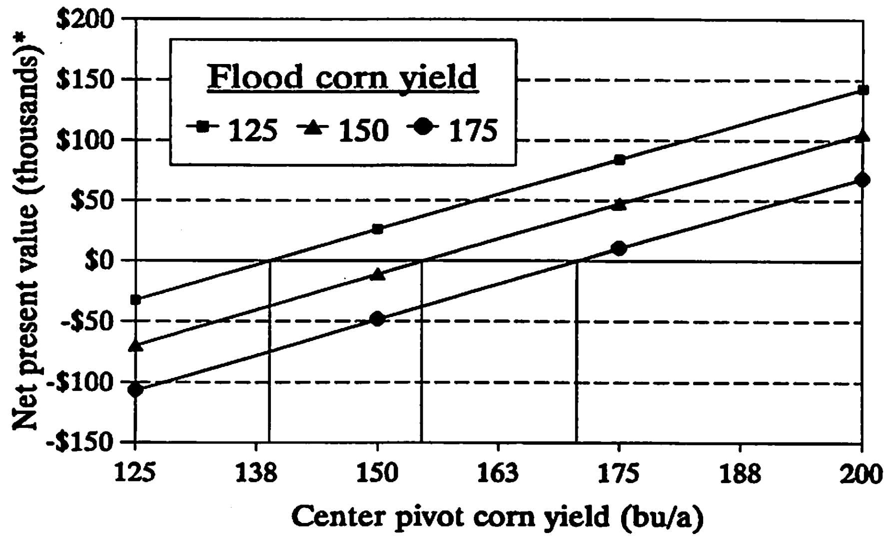


Figure 2. Net present value of converting from flood to center pivot sprinkler irrigation vs. irrigation pumping cost.



* Based on 126 acres irrigated for center pivot and 80 for flood.

Figure 3. Net present value of converting from flood to center pivot sprinkler irrigation vs. irrigated corn yield potential.

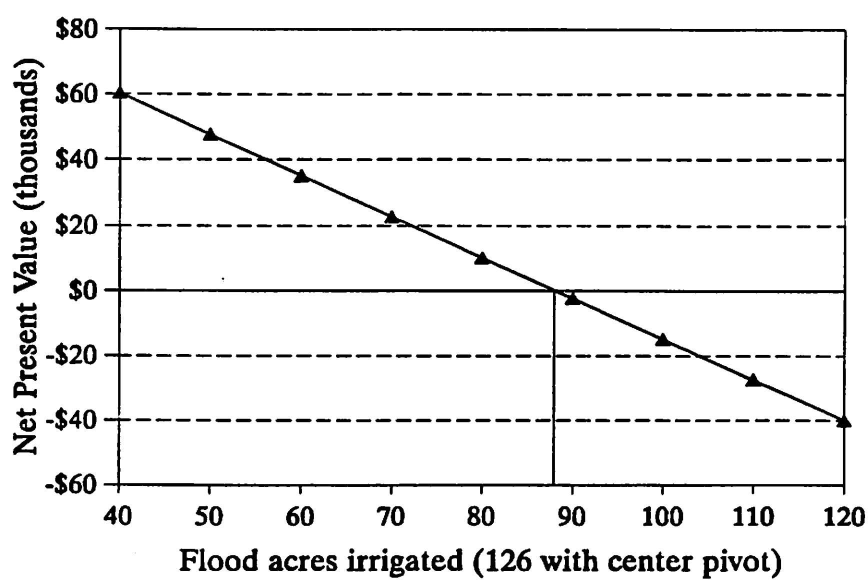


Figure 4. Net present value of converting from flood to center pivot sprinkler irrigation vs. acres irrigated with flood system.